REMARKS

Claims 1 and 7-26 were previously pending in the application. Claims 1, 7-16, 19, and 20 were withdrawn from consideration as directed to a non-elected invention and have now been canceled. Claim 17 has been amended, and claims 27-39 have been added.

Upon entry of the present amendment, claims 17, 18, and 21-39 are pending in the application. Claims 23-24 have been withdrawn as directed to a non-elected species.

Claim 17 has been amended to require that the process does not result in any reduction in molecular weight of the polyester (as supported at least on page 4, lines 30-31).

Entry of the above amendment is respectfully requested. The added limitation merely explicitly states an inherent characteristic of the present invention, as is clearly evident from the original application. Entry of the amendment is proper on the grounds that the amendment clearly places the application in condition for allowance.

New claims 27-39 are presented to further distinguish from the invention. In particular, new independent claim 27 contains all the limitations of claim 17 and further specifically requires that the polyester contains at least two pendant hydroxyl groups that are reacted with an ester of a carboxylic acid having a double bond activatable by actinic radiation, as supported on page 5, lines 21-23, and page 6, lines 7-18. Claim 27 further requires that the enzyme is selected from the group consisting of hydrolases that are carboxylester hydrolases (as supported by dependent claim 24); claim 27 further requires that the reactions are carried out at a temperature of 15 to 75°C (as supported on page 12, liens 13-19); wherein the water produced during the esterification of the polyester or the resultant hydroxyl-containing compounds is or are removed from the reaction mixture as they are forming or immediately after they have formed, as supported on page 13, lines 2-13. Finally, claim 27 further states that the resulting polyester is capable of use as a coating material in an outermost coat of a multicoat paint system, as supported by page 18, lines 11-14.

New independent claim 36 further requires that the ester of the carboxylic acid is an ester of acrylic acid or methacrylic acid (as supported on page 11, lines 16-20) and the enzyme is a

lipase catalyst obtained from at least one of Achromobacter sp., Aspergillus sp., Burkholderia sp., Candida sp., Mucor sp., Penicillium sp., Pseudomonas sp., Rhizopus sp., Thermomyces sp., and porcine pancreas, as supported on page 8, lines 30-33.

New dependent claims 28-29 are supported by dependent claims 14-15. Claim 30 is supported on page 30, lines 10-14. New claim 32 requires that the reaction is carried out in bulk without the addition of organic solvents or in the presence of small amounts, as supported on page 12, lines 9-11. Claim 33 requires that the process is carried out at a temperature of 20 to 70°C, as supported on page 12, lines 13-19. Claim 34 requires that an absorbent, specifically a molecular sieve (Claim 35), is used to remove hydroxyl-containing compound or water that forms from the reaction mixture during or immediately after its formation in the process, as supported on page 13, lines 1-13.

New dependent claims 37-39 require that the polyester comprises the reaction product of a trimethylolpropane monomer, a phthalic anhydride monomer, or a neopentylglycol and hexanediol monomer, as supported on page 19, lines 1-6.

1. Rejection of claims 17-18, 21-22, and 25-26 under 35 U.S.C. §103(a) as obvious over Weikard et al., U.S. 6,150,458, hereafter "Weikard" in view of Kobayashi et al., "Enzymatic Polymerization," hereafter "Kobayashi."

The Office Action states that Weikard discloses a process for the preparation of a (meth)acrylic acid ester by reacting a hydroxyl group containing polyester with (meth)acrylic acid in the presence of an esterification catalyst. The Office Action further states that Weikard points out that polymers obtained by the process can be used as radiation curable binders.

The Office Action concedes that Weikard is silent regarding conducting this process with an enzyme catalyst. 02/18/2009 Office Action page 3, para. 2.

Accordingly, the Office Action cites Kobayashi for allegedly teaching a process of polymer modification, in which a terminal hydroxy group of a polyester reacts with carboxylic acid, that is catalyzed by a lipase enzyme catalyst in order to give end-functionalized polyester (citing page 3813, part 4, "Polymer Modification"). The Office Action further cites Kobayashi for "pointing out that enzymatic polymerization can be conducted under mild conditions without using toxic

reagents by natural catalyst with 'green' appeal in commercial benefit and ecological requirement," citing page 3793, right column, third paragraph. 02/18/2009 Office Action page 3, para. 3. The Office Action alleges it would have been obvious to use the lipase catalyst teaching of Kobayashi in order to modify the polyester process of Weikard "under mild conditions without using toxic reagents…."

Applicants greatly appreciate the detailed basis of rejection but must respectfully disagree, particularly in regard to the inventions of claims 17, 27, 36, and 40-42.

To briefly recap, the present invention is directed to the functionalization of a polymer containing at least one pendant and/or terminal group (at least two pendant groups in independent claims 27 and 36) that can be activated with actinic radiation, which resulting functionalized polymer can be used for preparing a composition curable with actinic radiation. It was found that preparing such functionalized polyesters by conventional polymer-analogous reactions was problematic, since the direct reaction of hydroxyl-containing polyesters with carboxylic acids or carboxylic ester groups can lead to a cleavage of the polyester. Similarly, the reaction of polyesters containing carboxylic acid groups or carboxylic ester groups with hydroxyl-containing compounds such as hydroxyethyl acrylate can lead to a reduction in molecular weight.

On the other hand, the use of various enzymes in various *polymerization* reactions is known, as shown by Kobayashi. Whether and, if so, to what extent these reactions can be transferred to the preparation of a polyester containing groups that can be activated with actinic radiation were unknown. The predictability of enzymes or catalysts for new reactions is notoriously unpredictable, whereas the demands of, or requirements for, a commercially practical catalyst, especially to replace one in commercial practice, must be high. Not just any catalyst reaction to produce just any reaction will do. The reaction must be efficient, produce high yield and high conversion, produce the desired product and characteristics, not produce undesirable residues, not involve side reactions, not result in high viscosity due to unreacted groups, and the like. One particularly relevant feature is the effect of a catalyst on molecular weight and cleavage of the polymer involved in the reaction.

In the present invention, the object was to find polyesters containing at least one pendant and/or terminal group that can be activated with actinic radiation and that do not suffer from the disadvantages of the prior art, but which can instead be prepared by means of a process that does not cleave the polyesters (which can lead to a reduction in molecular weight), while having an advantageously low viscosity.

The process of the claimed invention provides a product that unexpectedly avoids reduction in molecular weight of the polyesters. Moreover, by means of the process of the invention it was possible to gain outstanding reproduction of the profile of properties necessary for the particular end use. The compositions of the invention can be advantageously used as coating materials, particularly as topcoat materials or clearcoat materials. Such clearcoat materials are used for producing multicoat color and/or effect systems, especially multicoat color and/or effect paint systems using wet-on-wet techniques. Since the resultant clearcoats of the invention are the outermost coats of the multicoat paint systems, they are critical to the overall appearance and protect the color and/or effect coats against mechanical and chemical damage and damage due to radiation. Consequently, any deficiencies in the hardness, scratch resistance, chemical stability, or yellowing stability are highly problematic in the clearcoat.

It was found that clearcoats using the enzyme-catalyzed functionalized polyesters of the present invention are highly scratch resistant and, after exposure to scratching, exhibit only very small losses of gloss. At the same time they exhibit high hardness, a particularly high chemical resistance, and adhere very firmly to the color and/or effect coats. Page 18, lines 11-20, of the original specification.

The Office Action cites Weikard for a process of preparing esters of (meth)acrylic acid. Weikard is directed, however, to solving certain problems that have nothing to do with enzyme catalysts. In fact, Weikard teaches away from the use of enzymes to catalyze functionalization of polyesters as claimed by Applicants.

Weikard is directed to three problems. First, a stoichiometric excess of hydroxy groups produces undesirably high viscosities due to the residual concentration of hydroxyl groups in the polyester. Col. 1, lines 25-28. Second, the use of alkali metal hydroxides or tertiary amines as

esterification catalysts was found to be detrimental to the hardness and resistance of the resulting coatings. Col. 1, lines 29-37. Third, it was disadvantageous that the solvent had to be removed by distillation before the non-esterified (meth)acrylic acid could be reacted with epoxide-containing compounds. Col. 1, lines 43-46.

Weikard solved these problems by *using an acid catalyst* and reacting both the acid catalyst and the unreacted (meth)acrylic acid in the esterification solvent with oxirane compounds until an acid number of less than or equal to 5 mg KOH/g was obtained. Col. 1, lines 56-63. The solvent is then removed by distillation. The process is carried out in a solvent that is immiscible with water. Col. 2, lines 49-50. It is important to note here that Weikard did not simply specify the use of an esterification catalyst as a generic ingredient in their specification, which would carry an implication that any known esterification catalyst could be used. To the contrary, Weikard's selection of an acid catalyst was a critical component of their invention, with the concomitant teaching that it solved the above-described problems to which Weikard's invention was directed. Applicants submit that, faced with the clear teaching of Weikard that use of an acid catalyst was required in order to avoid problems such as poor coating hardness and resistance, one of ordinary skill in the art would be highly unlikely to replace the required acid catalyst of Weikard with Kobayashi's enzymatic catalyst.

The Kobayashi reference is a lengthy 25-page monograph devoted almost exclusively to the use of enzymes as polymerization catalysts, not to functionalize an already-formed polymer as specified in Applicants' claimed invention. The lone reference to functionalization of already-formed polymers is found at page 3813, where the reference briefly mentions that that lipase catalysts have been used for functionalizing poly(ε-CL). However, Kobayashi goes on to state that "[u]nder selected conditions, lipase could act as a hydrolytic degradation catalyst of polyesters", which is what causes the reduction in molecular weight that Applicants' invention seeks to avoid. Although Kobayashi reports that the degradation of the polyester can be reversed by removal of solvent from the mixture, Weikard clearly teaches col. 2, lines 49-50 that their process is "carried out in a solvent". Thus, one skilled in the art would expect from the combined

teachings that use of Kobayashi's enzyme catalyst in Weikard's process would yield precisely the reduction in molecular weight that Applicants' invention seeks to avoid.

Furthermore, new claims 27 and 36 require that the polyester comprises at least two pendant, not merely terminal, groups that are activatable by actinic radiation so that it is advantageously useful in an automotive topcoat. There is no suggestion whatsoever by Kobayashi of using enzyme catalysts to append pendant functional groups onto already-formed polymers.

Claims 42, 43, and 44 are each directed to a process for preparing a multicoat paint system that utilizes the process of claims 17, 27, and 36 to prepare the topcoat. Applicants submit that claims 42-44 are clearly patentable over Weikard and Kobayashi because one of ordinary skill in the art would not replace Weikard's acid catalyst with Kobyashi's enzyme catalyst for use in a topcoat formulation due to Weikard's teaching that their invention requires an acid catalyst to avoid the prior art problems of low hardness and resistance. Good hardness and resistance are highly important properties for the topcoat of a multicoat paint system.

The Office Action asserts that it would be obvious to one of ordinary skill to use lipase catalyst per the teaching of Kobayashi that such catalysts offer "green" appeal for both commercial benefit and ecological requirement. In view of the single paragraph on functionalization of already-formed polymers out of 25 pages of disclosure, Applicants submit that the so-called "green" benefit constitutes at most an invitation to try enzyme catalysts for such use, particularly since the Office Action fails to articulate any particular environmental problem with Weikard. Moreover, Applicants respectfully submit that such a vague and general benefit is profoundly insufficient to overcome the clear expectation from the teaching of the primary Weikard reference that *acid* catalysts are needed for their invention to work. Without such acid catalysts used in accordance with their invention, Weikard teaches that various prior art problems are experienced, such as undesirable increases in viscosity, loss of hardness and resistance, or the burden of having to remove solvents, which can create its own set of problems.

CONCLUSION

Applicants respectfully submit that the Application and pending claims are patentable in view of the foregoing amendments and/or remarks. A Notice of Allowance is respectfully requested. As always, the Examiner is encouraged to contact the Undersigned by telephone if direct conversation would be helpful.

Respectfully Submitted,

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Monday, October 19, 2009
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